



Airborne Use of Traffic Intent Information (AUTRII)

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AUTRII Research Issues

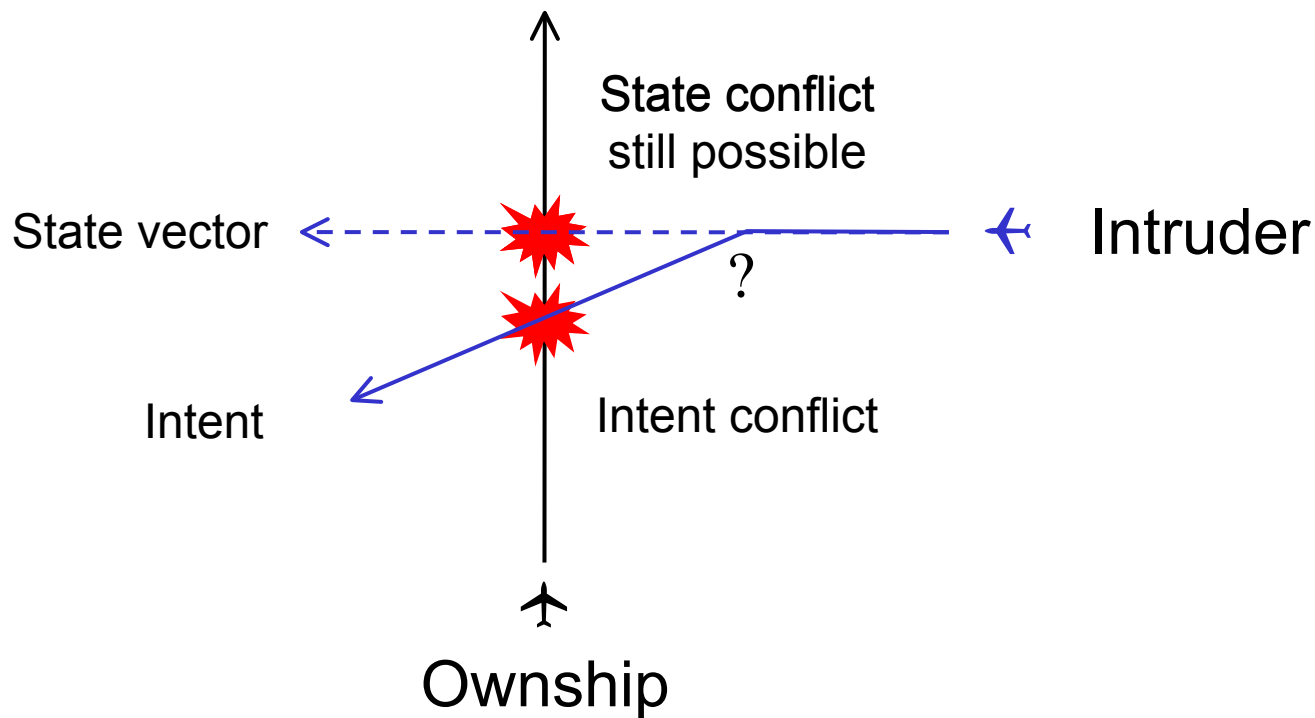
Distributed Air / Ground Traffic Management

- How does availability and use of traffic intent information affect pilot decision making and flight performance in the *constrained en-route environment*?
 - Flow management constraints (i.e., meeting *required time of arrival*)
 - Airspace constraints (e.g., weather, SUA)
 - Performance constraints (i.e., available degrees of freedom for maneuvering)
 - Economic constraints (e.g., cost index, passenger comfort)
- How is the impact of using traffic intent information affected by *operational complexity*?
 - Traffic density



Conflicts Detected with State and Intent Information

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AUTRII Hypotheses

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The ***combined*** use of state and intent information:

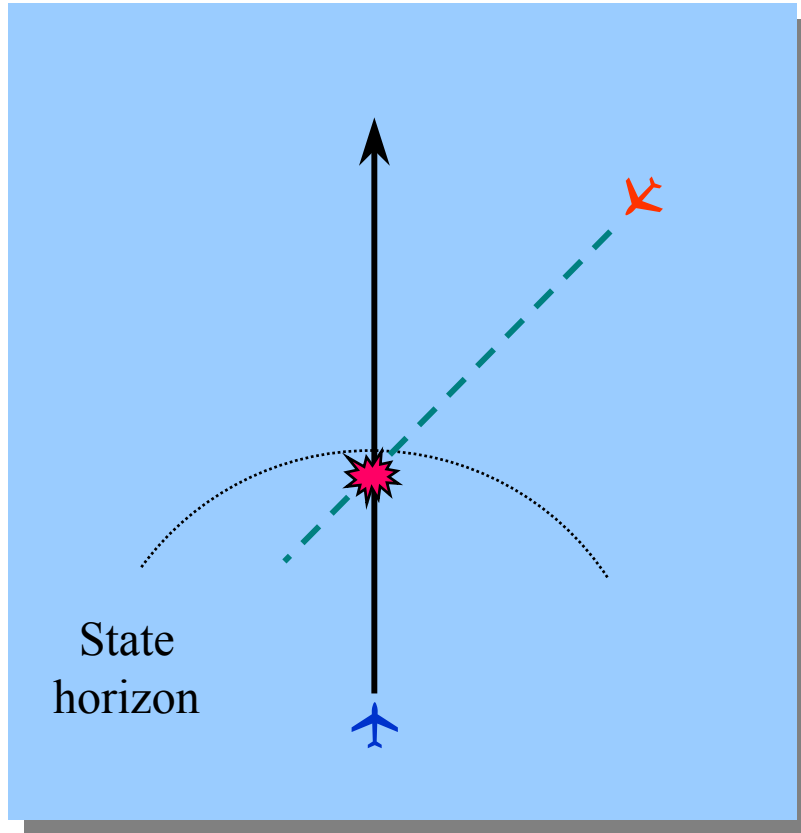
- Reduces adverse effects of increased operational complexity on flight efficiency and safety by
 - permitting the pilot to identify and resolve conflicts further in advance
 - allowing pilots to use resolution advisories to meet multiple constraints into a single, stable solution
 - increasing error tolerance through redundancy in conflict detection
 - complementing conflict prevention (i.e., ownship maneuvering threat information) with intruder maneuver threat information
- Improves the pilot's response to critical events by
 - improving pilot awareness of critical event times (e.g., waypoint passage)
 - reducing pilot reaction time in the event of an intent deviation (blunder)
- Impacts pilot decision-making time and cognitive workload in maintaining separation by
 - reducing occurrences of unnecessary maneuvering (e.g., “nuisance” alerts)
 - placing the number of maneuver decisions per conflict in the pilot's control
- Increases pilot confidence in the CD&R automation advisories and acceptance of expanded role in autonomous operations in complex en-route environments



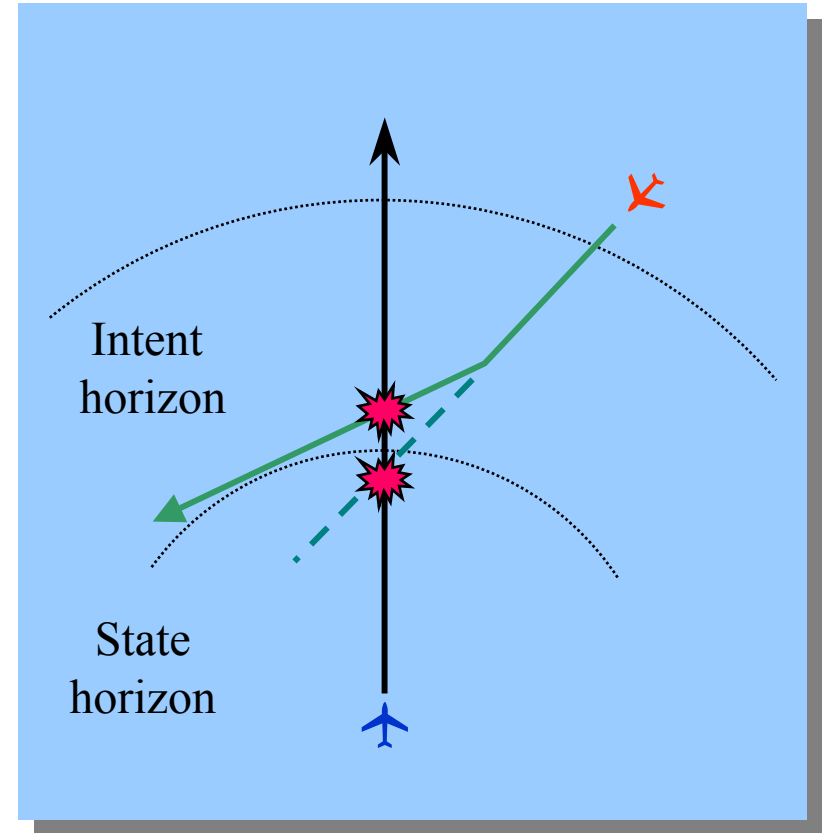
Comparison of Two Operational Modes

5

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state only



state + intent

conflict detection information



Initial Experiment Design

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- **Independent Variables**

- *Information content*: state vs. state+intent
 - Information available to CD&R and pilot-flying
- *Operational complexity*: low vs. high
 - Traffic volume: 1x vs. 3x 1997 recorded levels for ZFW
- *Conflict situation*
 - 4 conflict types in each above condition, with
 - lateral & vertical approach conditions
 - meet RTA at end of each conflict segment



Initial Experiment Design: Metrics

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- **Dependent Variables (examples)**
 - **Human Performance**
 - Cognitive workload
 - Communications workload (e.g., request for additional information)
 - Response latency (secondary task measure)
 - **Efficiency**
 - RTA compliance (variance)
 - Maneuver (type, trajectory)
 - Flight time, fuel burn
 - **Safety**
 - Pilot conflict detection and resolution time
 - Situation awareness / loss of separation
 - **Usability**
 - Frequency and ease-of-use measures
 - Information use / misuse
 - **Acceptance / Suitability**
 - Resolution advisory compliance
 - Preference ratings



Display Concept

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- **Use existing MD11 Nav Display features**
- **Complement with features of NASA Ames CDTI**
 - symbology
 - pilot selection
 - predictors/flight plan presentation
 - data tags
- **Complement with features of NLR CDTI**
 - Predictive ASAS bands on heading, speed, and vertical speed scales represent “no-go” zones
- **Resolution advisories are provided in event of a conflict alert**
 - pilot executes these advisories via MCP (state only)
 - pilot executes via MCP or FMS (state+intent)



Conflict Alerting Blueprint

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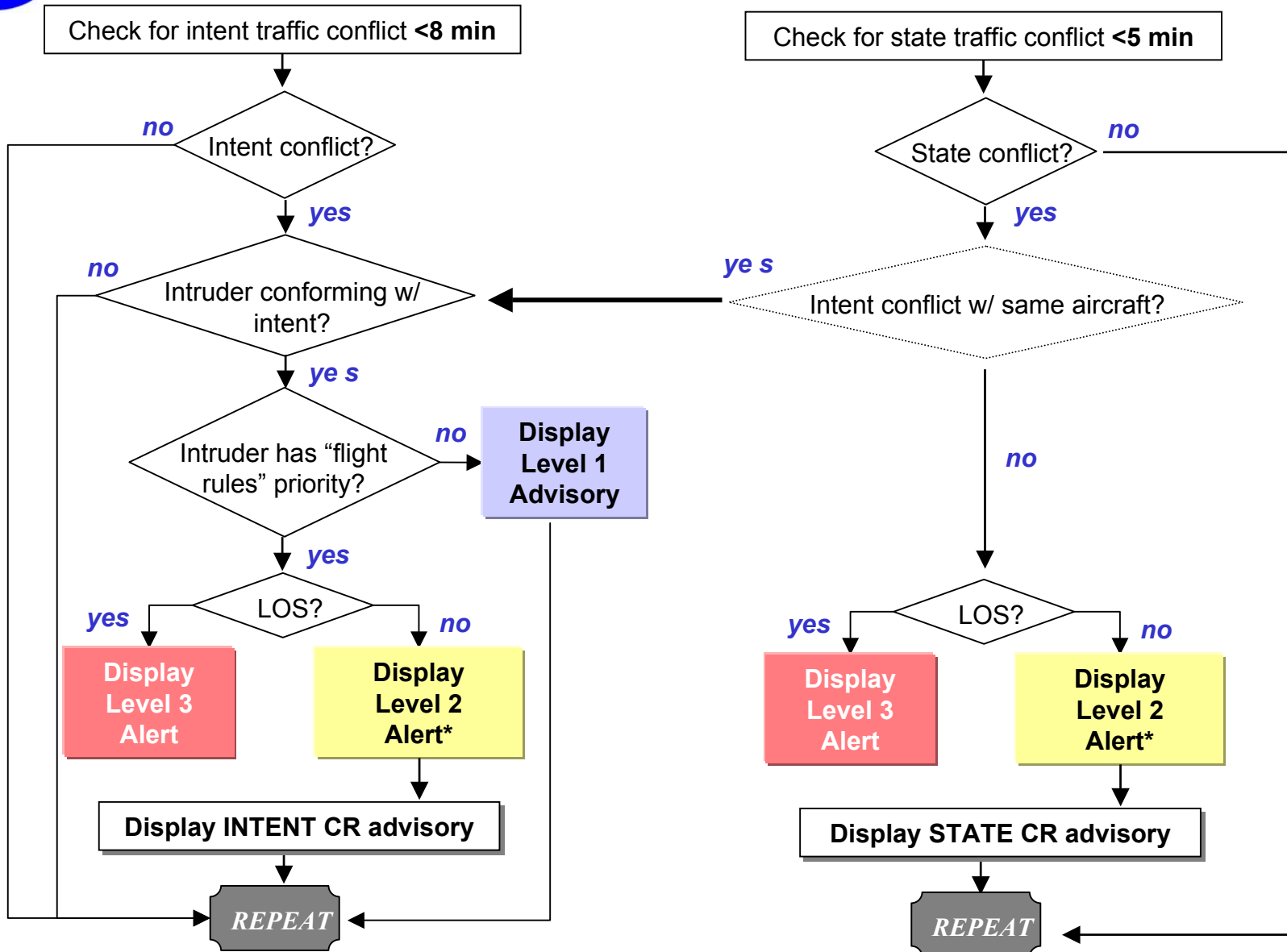
- **AUTRII CDTI conflict alerting uses the MD-11 alerting scheme as a blueprint**

| Information Priority | Format | Description |
|----------------------|-------------|--|
| Level 0 | Cyan | Pilot does not need to be immediately aware of this information. |
| Level 1 | Amber | Immediate pilot notification of this information but no current/future action required by the pilot. |
| Level 2 | Amber/boxed | Immediate pilot notification of this information, future action required by the pilot. |
| Level 3 | Red/boxed | Immediate pilot notification of this information, immediate action required by the pilot. |



Conflict Alerting Logic (State + Intent)

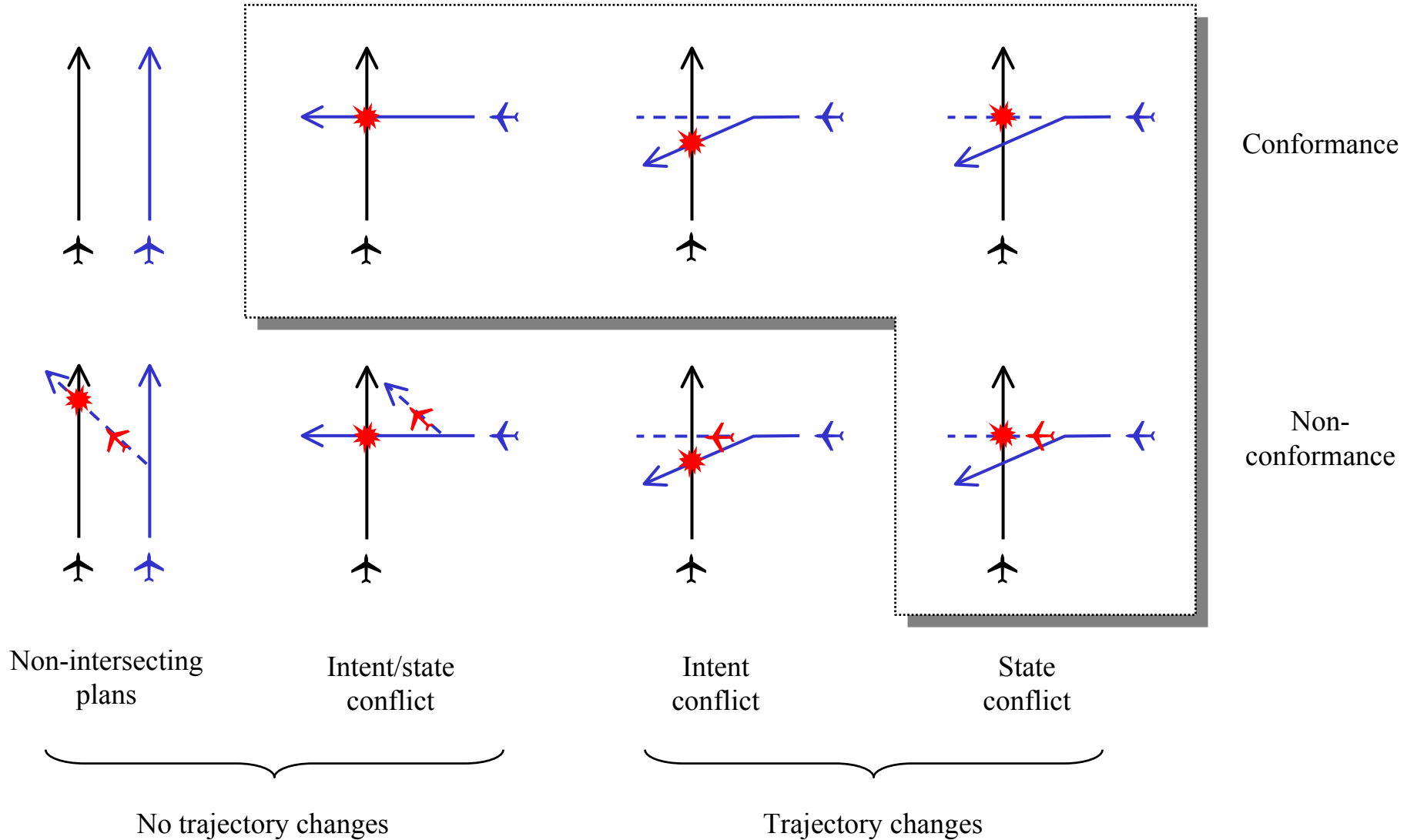
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Conflict Types

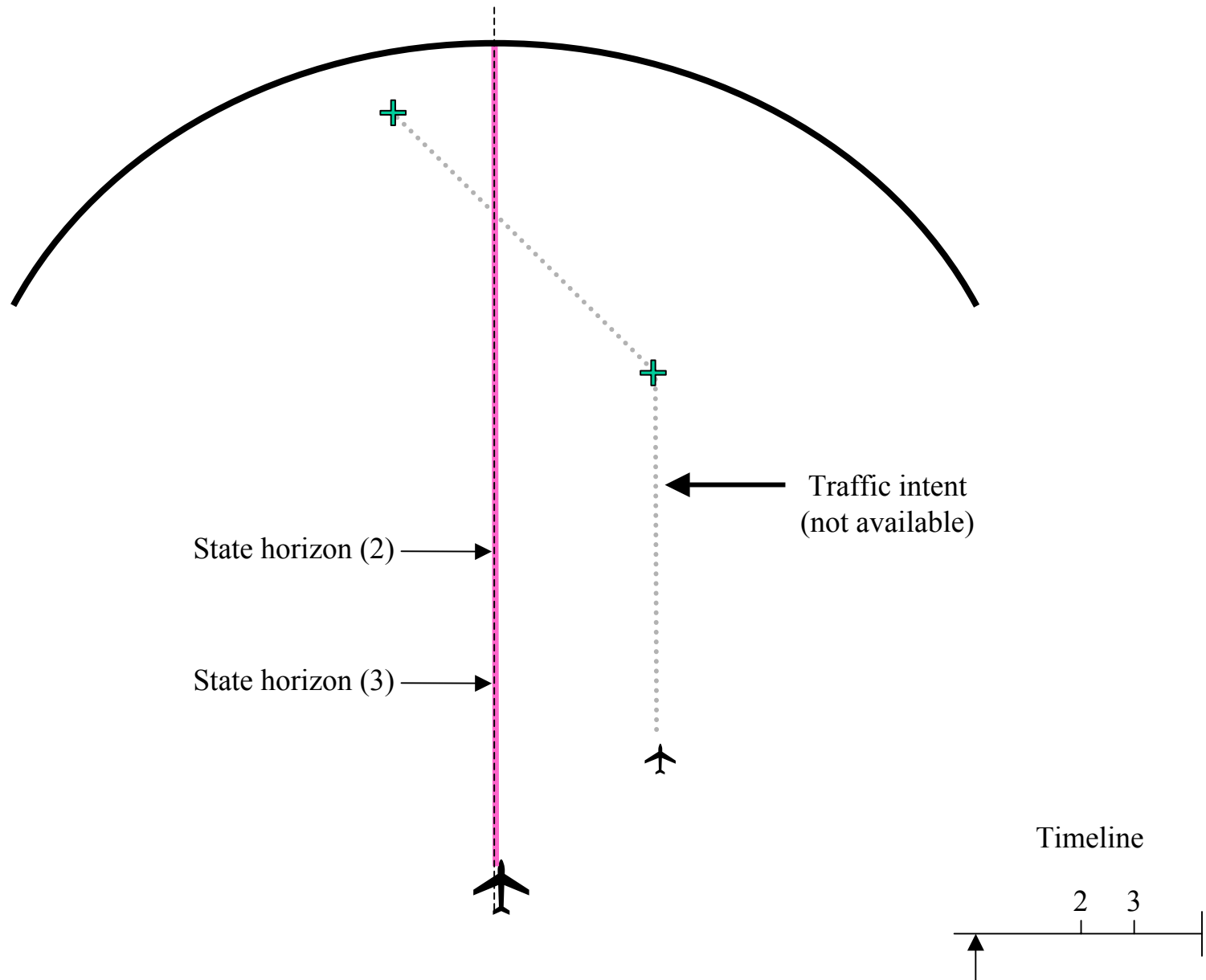
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State Operations

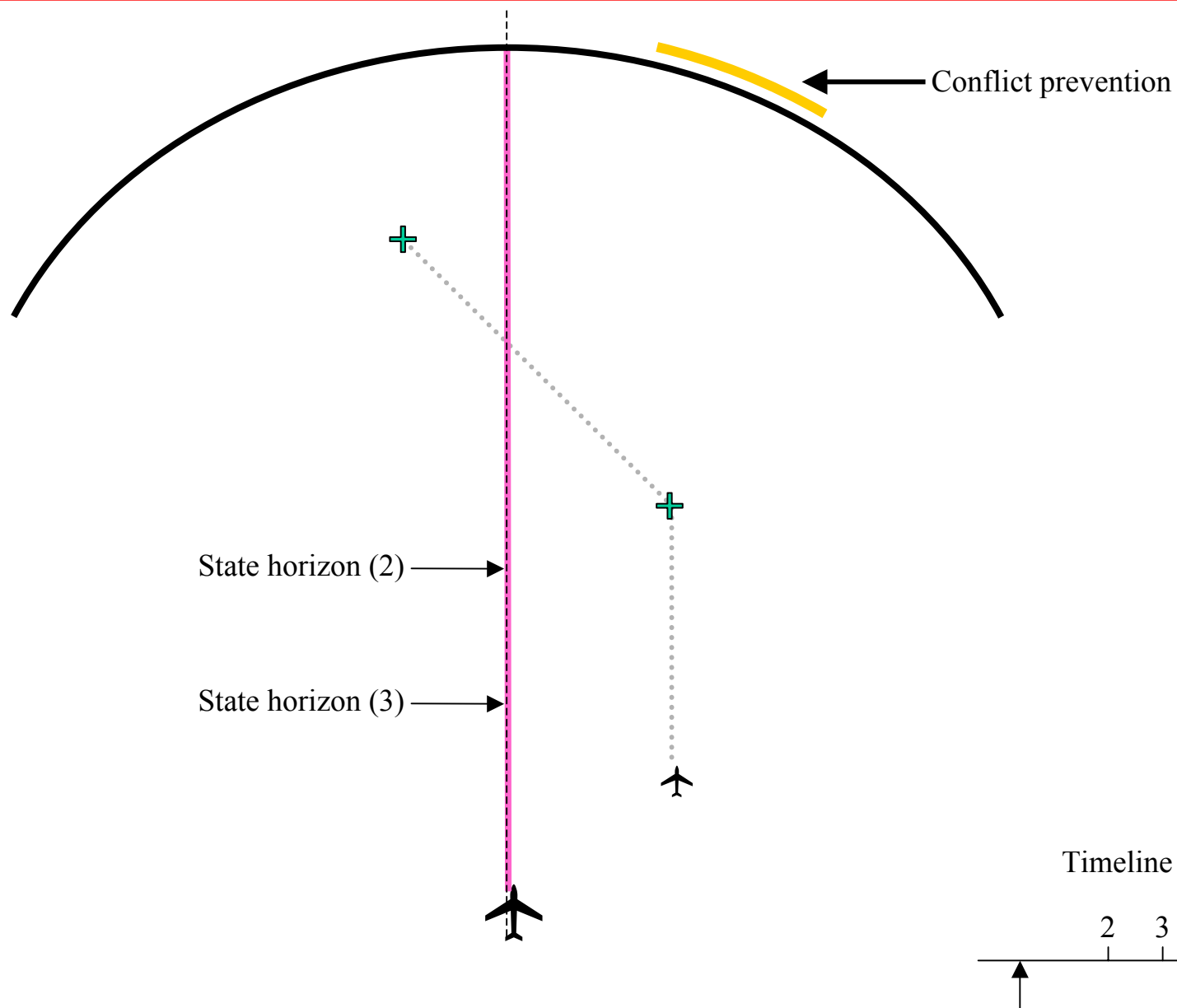
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State Operations

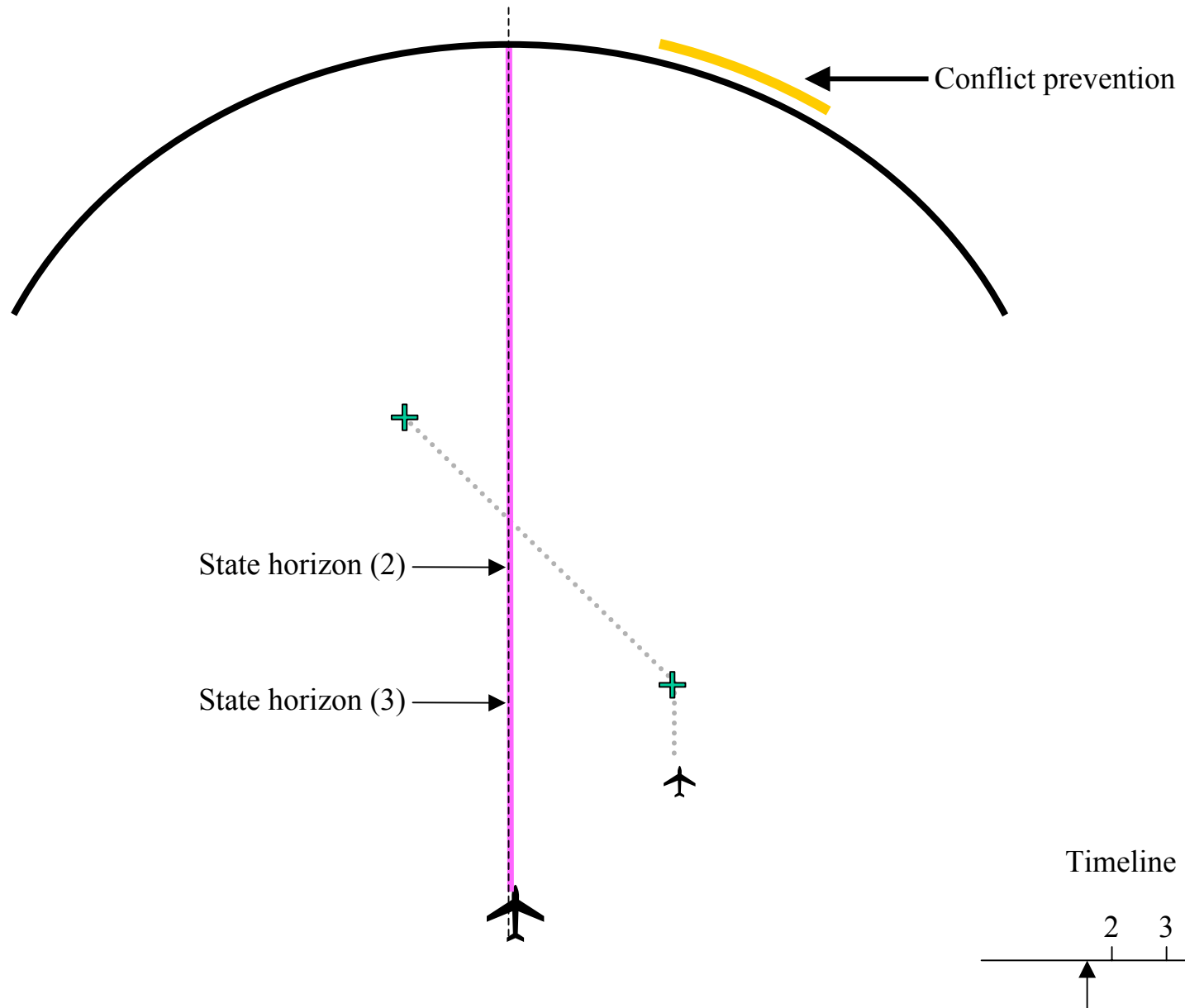
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State Operations

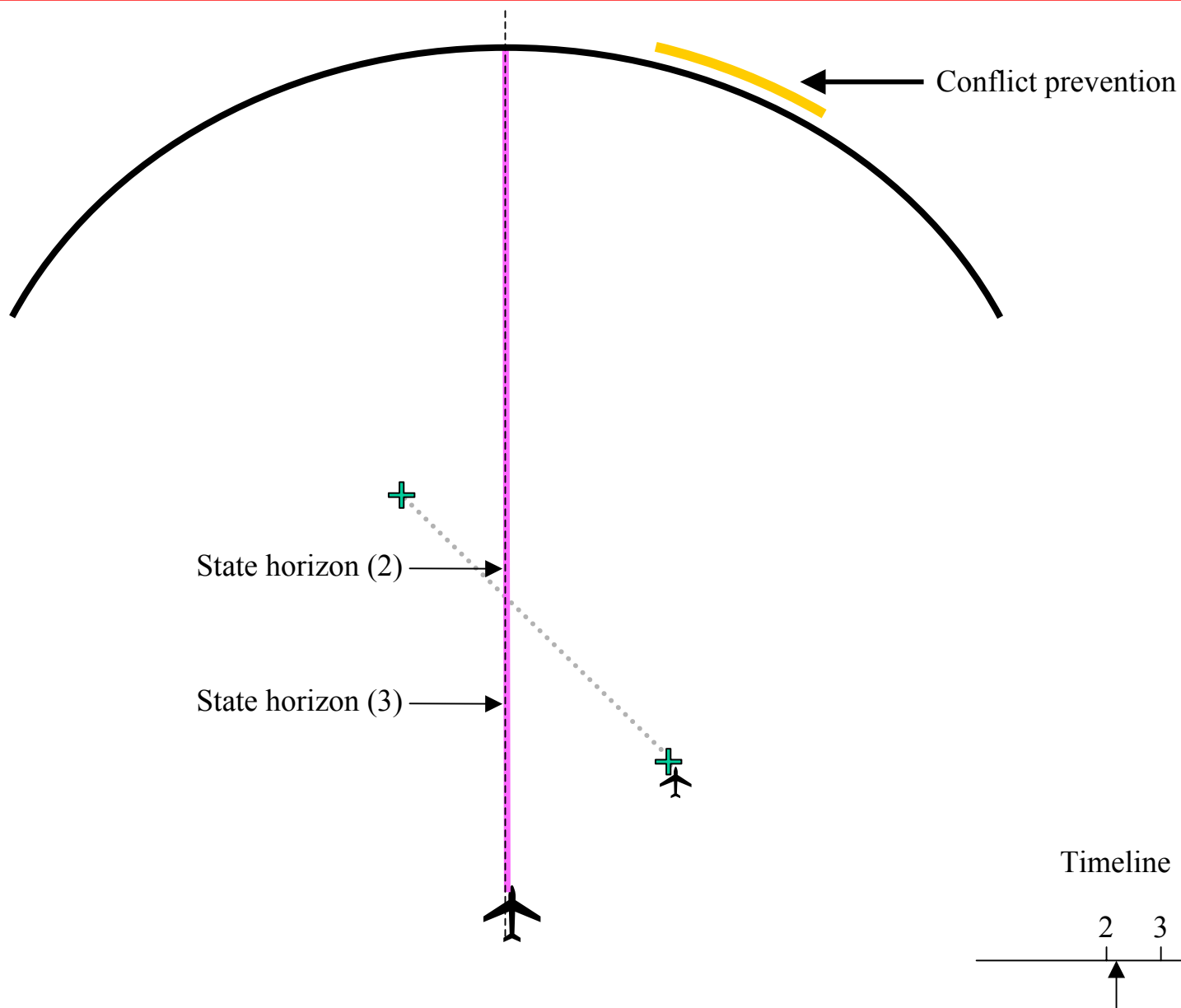
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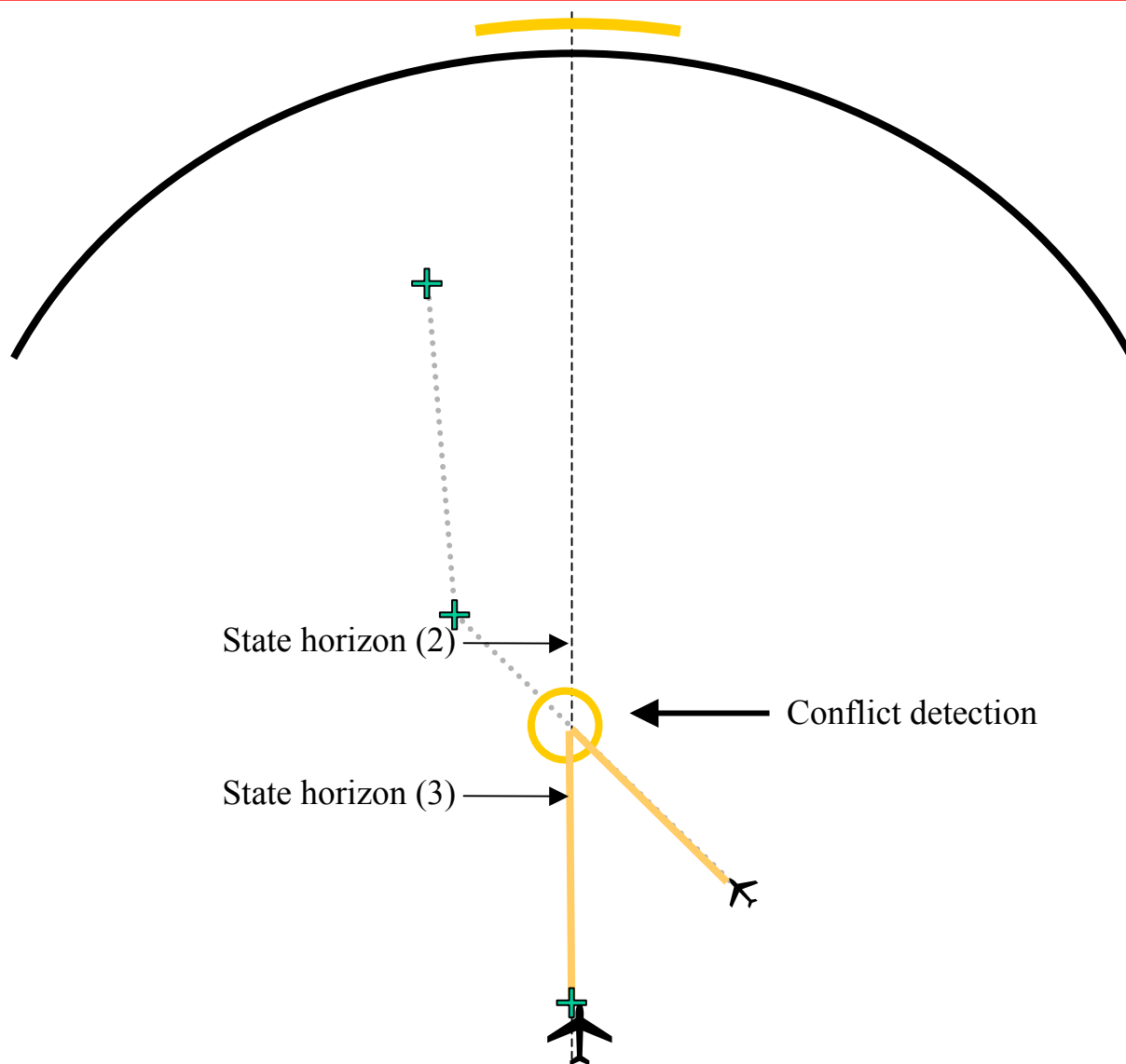
State Operations

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State Operations

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State horizon (2)

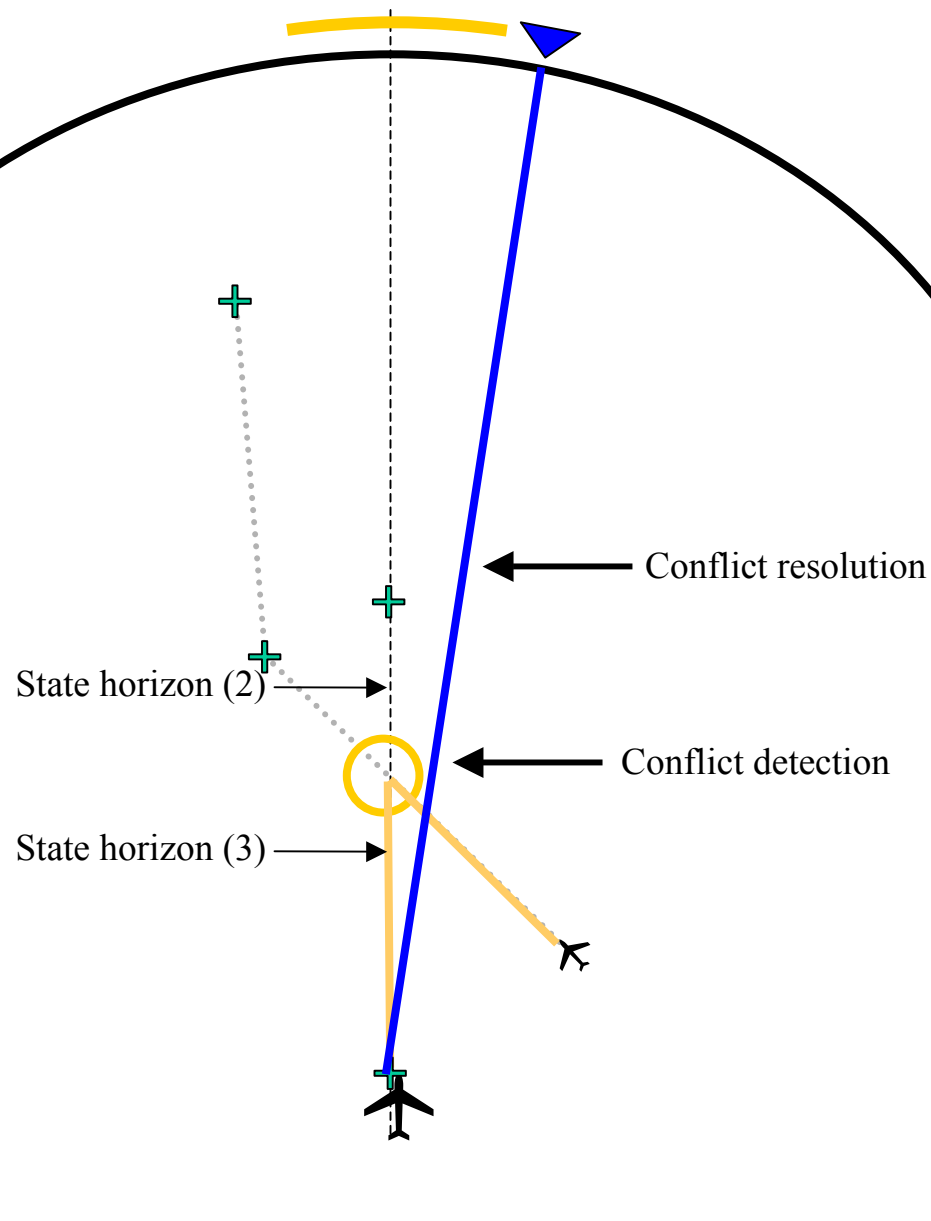
Conflict detection

State horizon (3)

Timeline

2 3

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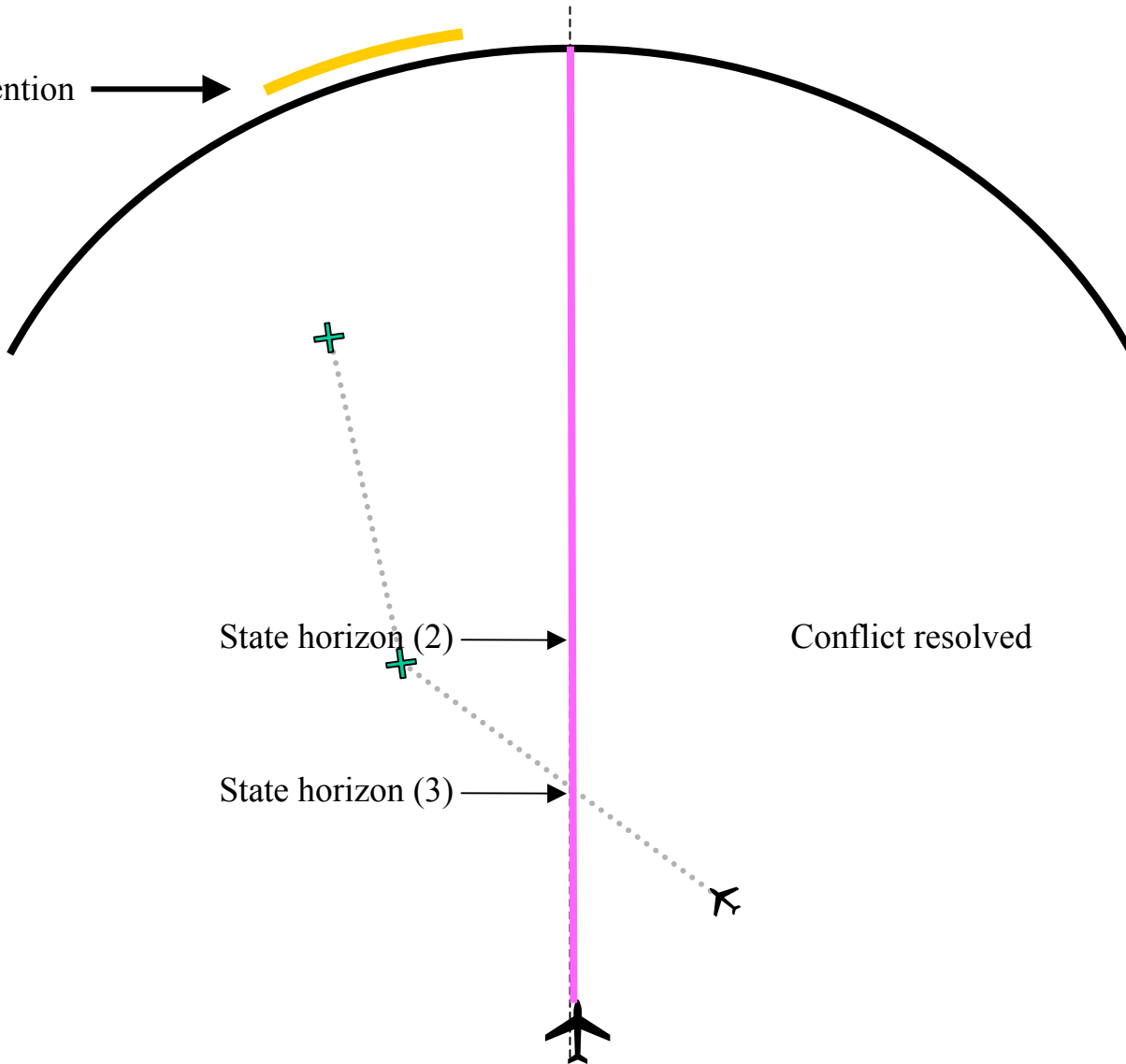


State Operations



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Conflict prevention

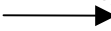


State horizon (2)



Conflict resolved

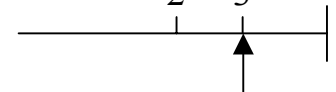
State horizon (3)



Timeline

2

3



State Operations



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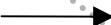
Conflict prevention
w/ heightened alert



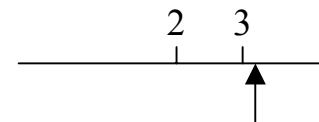
State horizon (2)



State horizon (3)



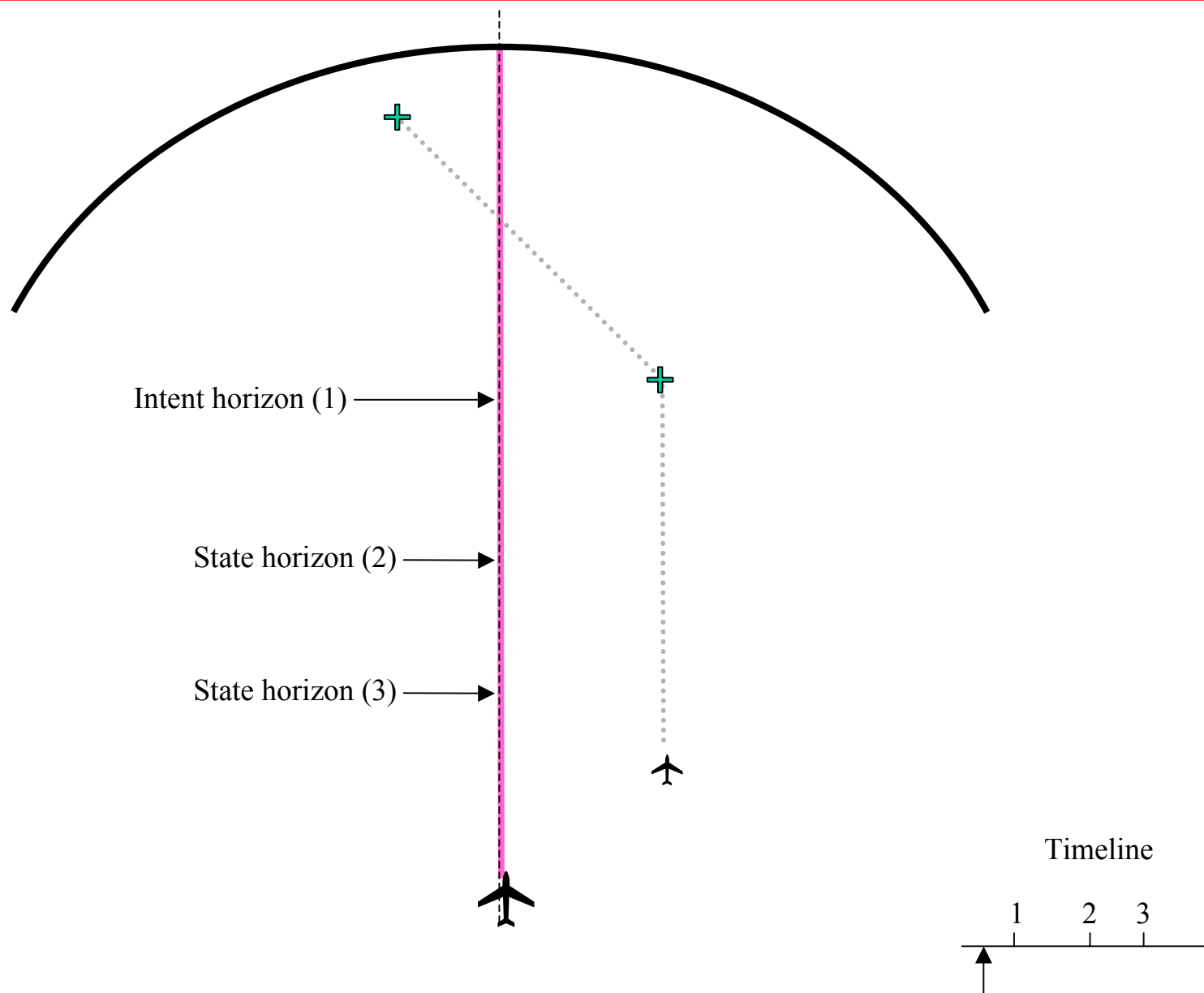
Timeline





State + Intent Operations

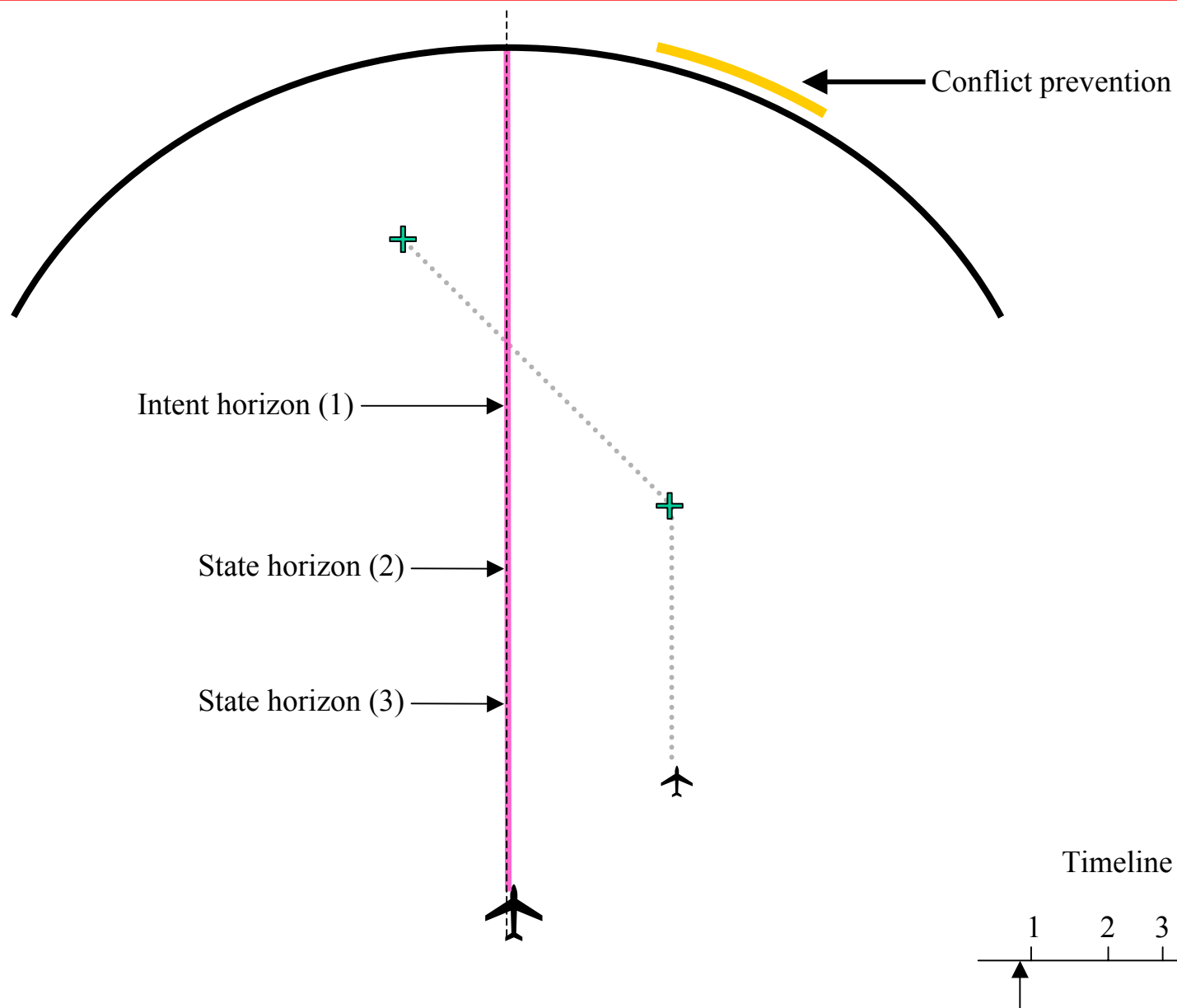
Distributed Air / Ground Traffic Management





State + Intent Operations

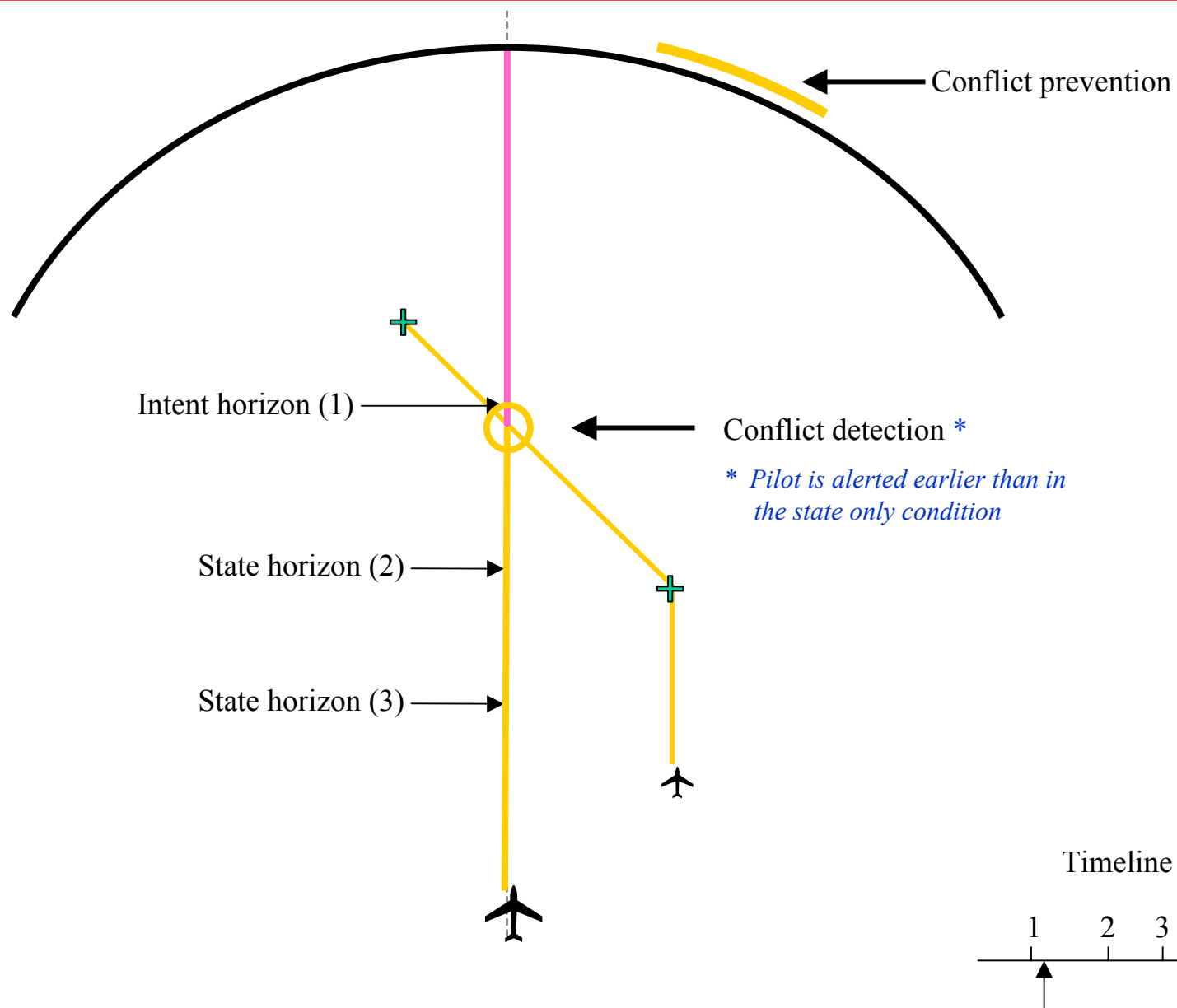
Distributed Air / Ground Traffic Management





State + Intent Operations

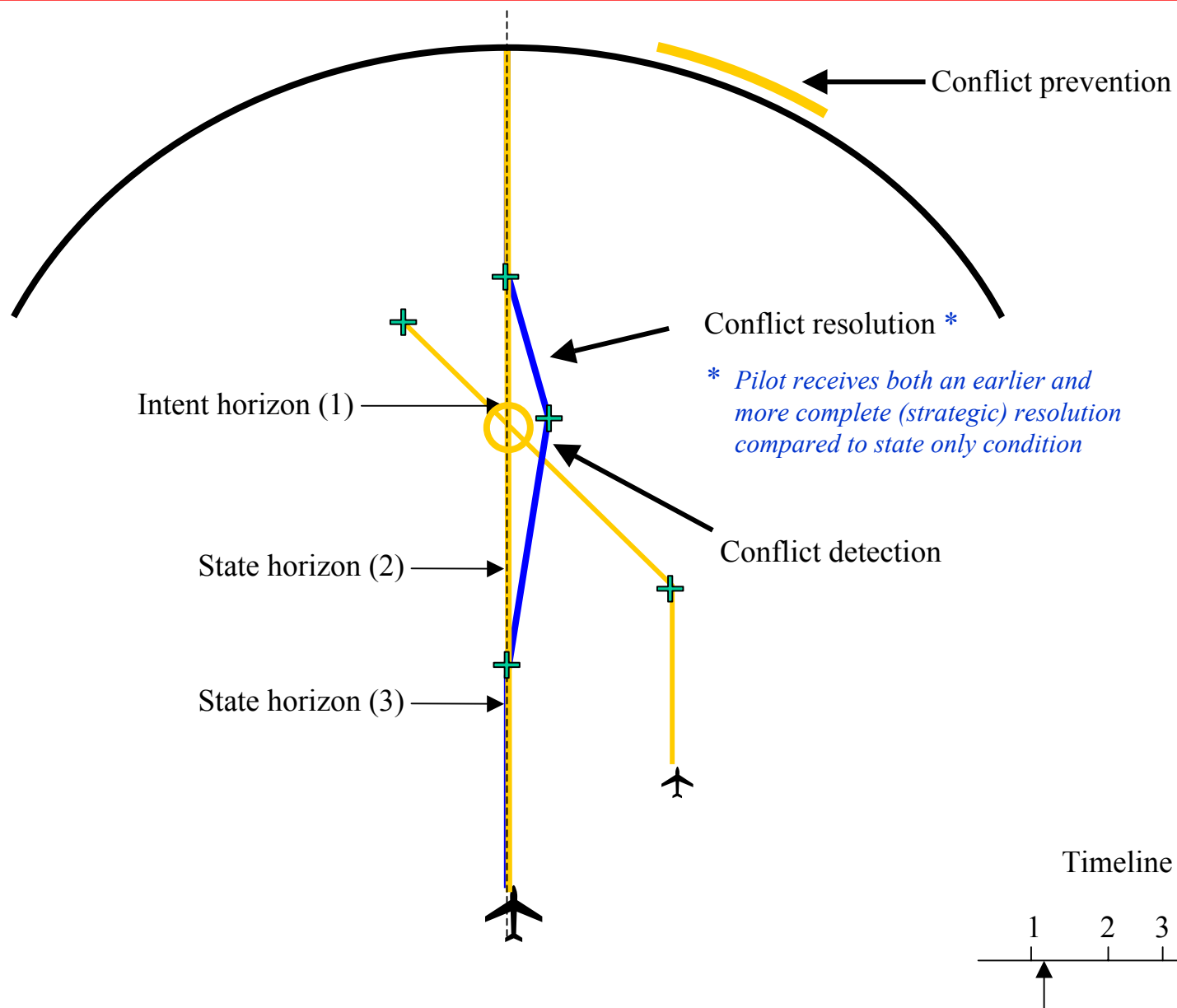
Distributed Air / Ground Traffic Management





State + Intent Operations

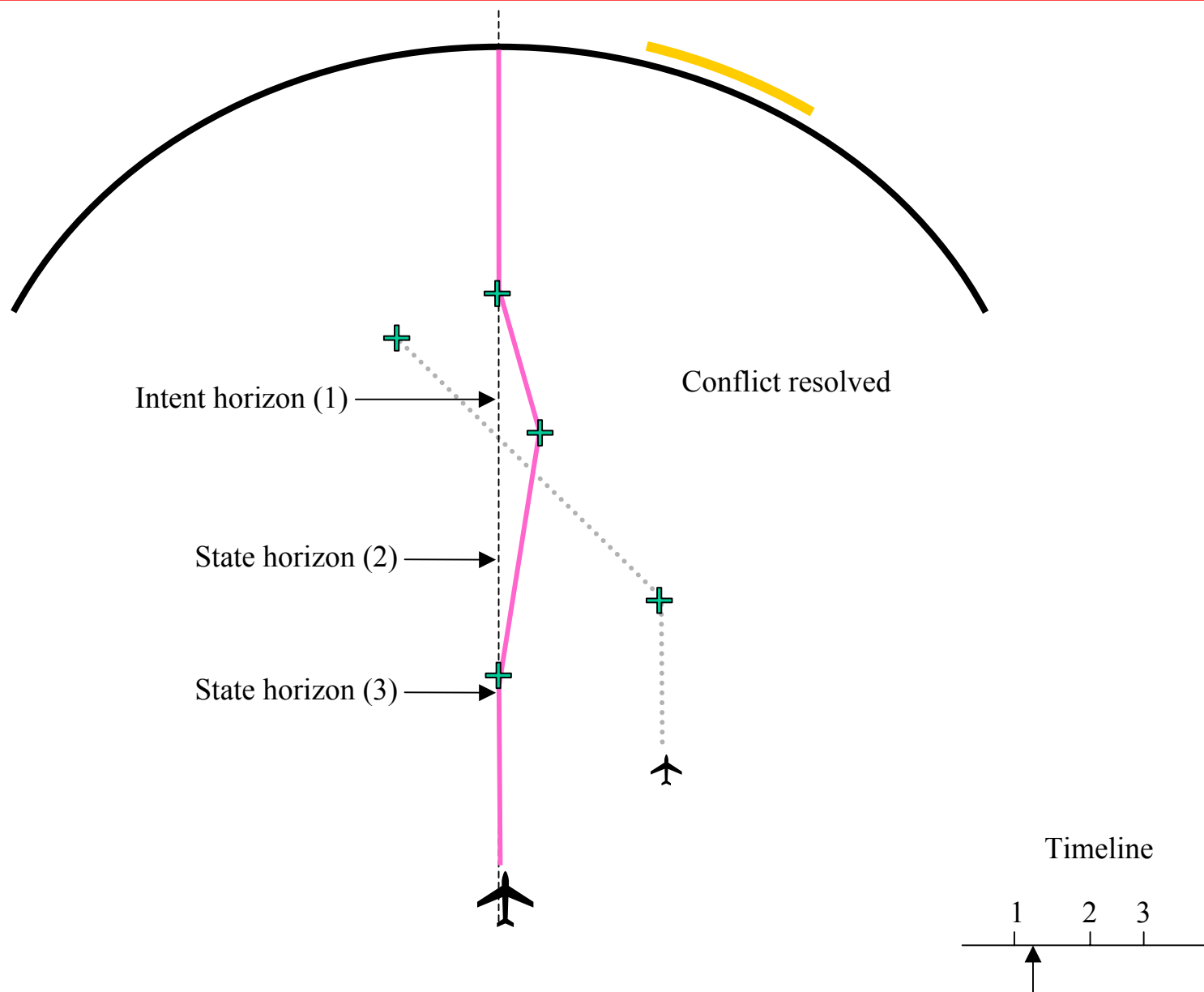
Distributed Air / Ground Traffic Management





State + Intent Operations

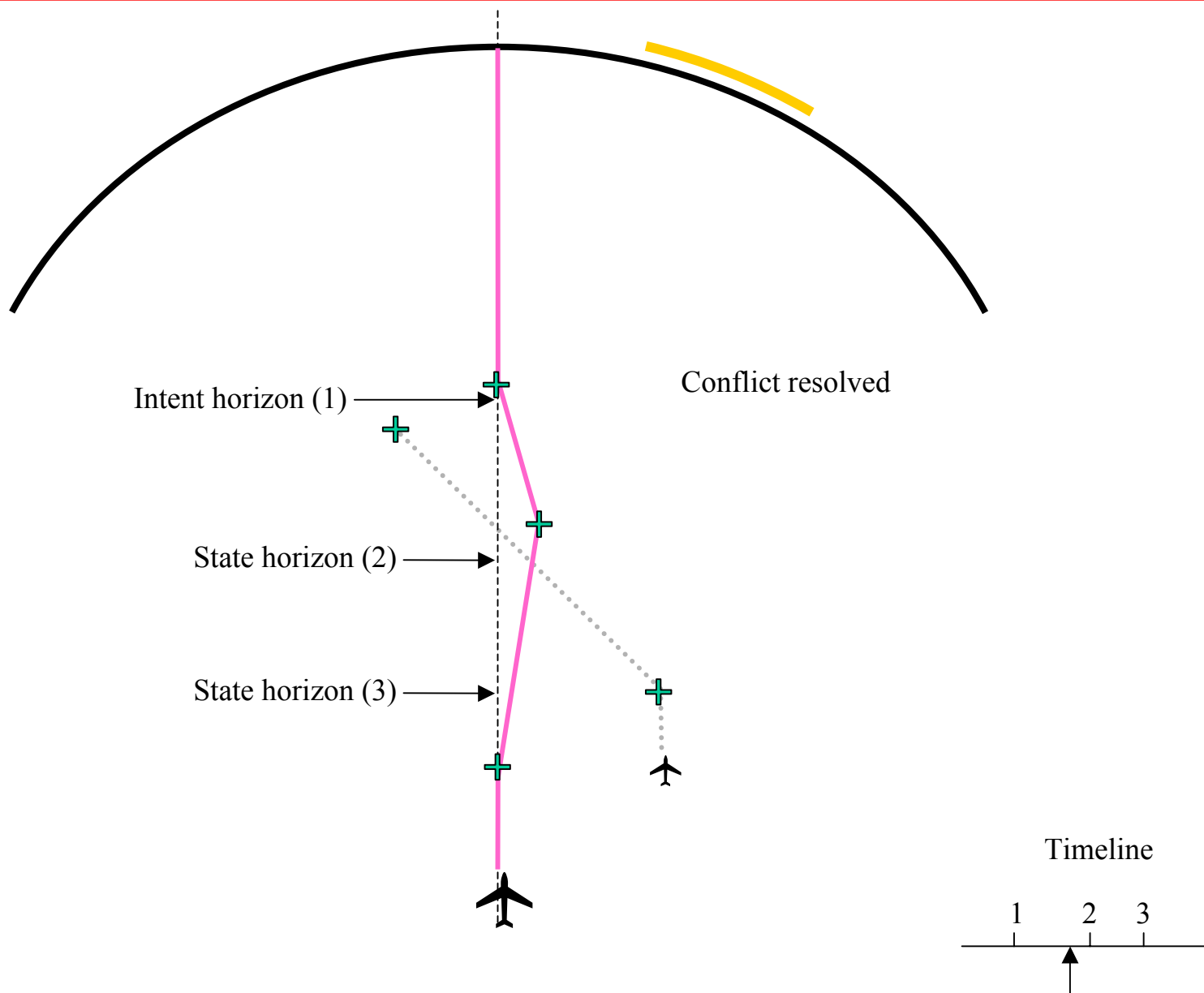
Distributed Air / Ground Traffic Management





State + Intent Operations

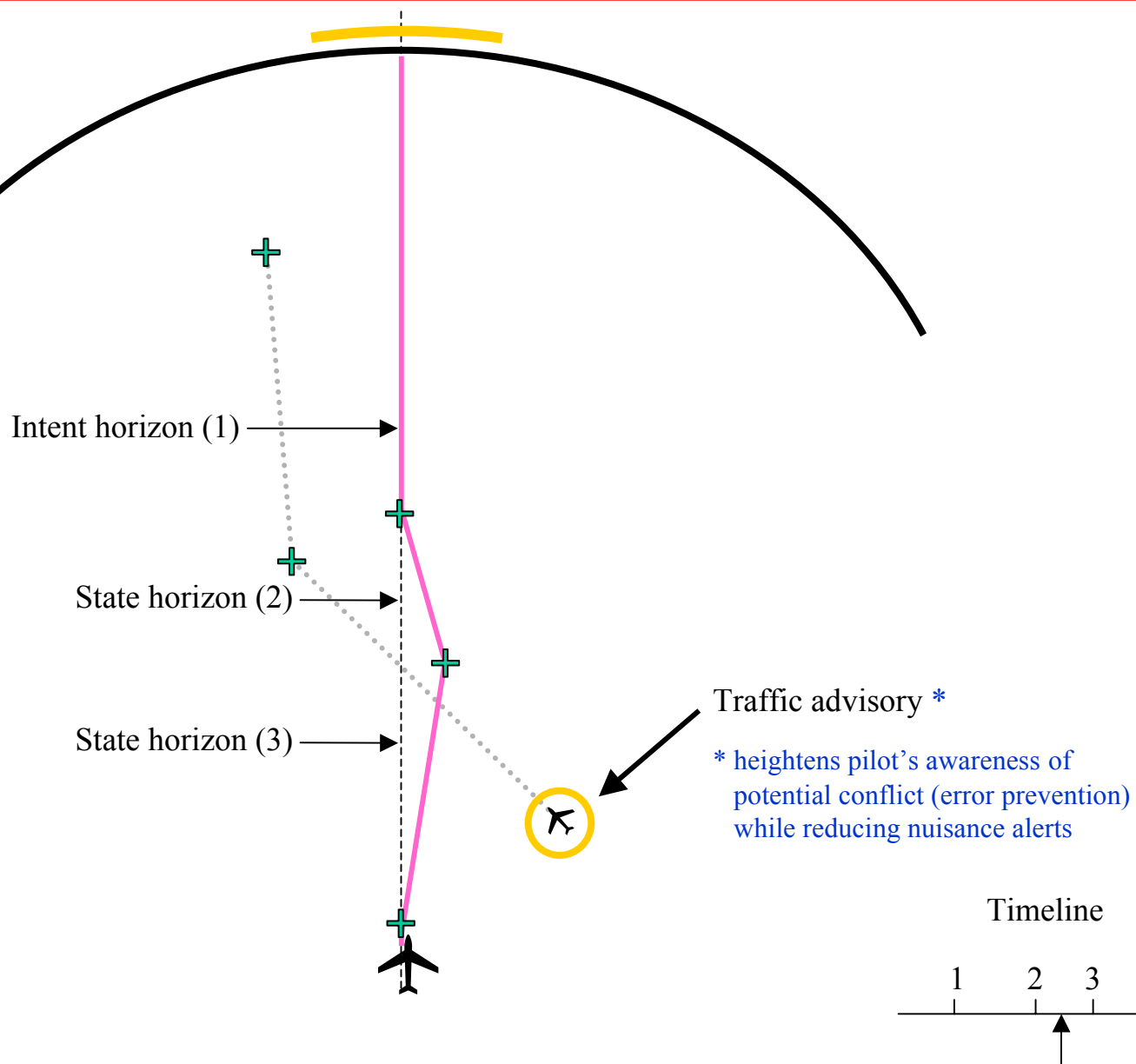
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State + Intent Operations

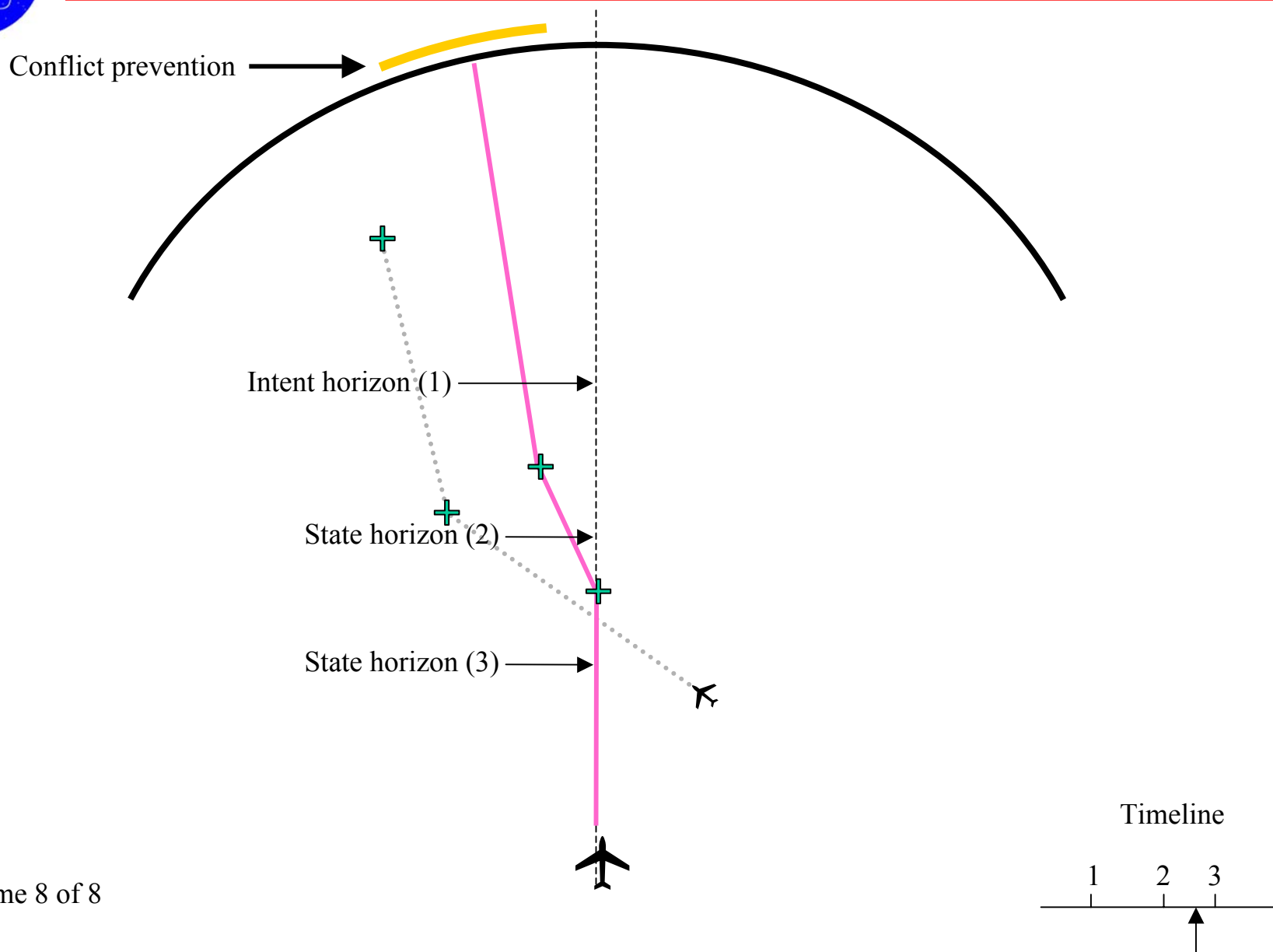
Distributed Air / Ground Traffic Management





State + Intent Operations

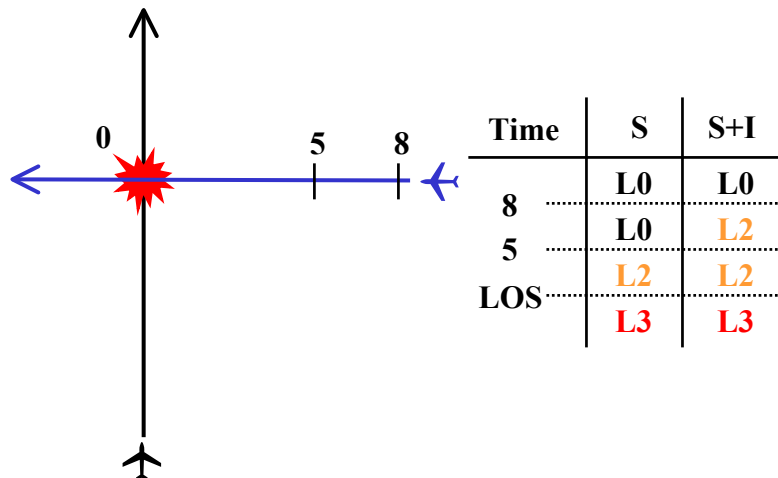
Distributed Air / Ground Traffic Management



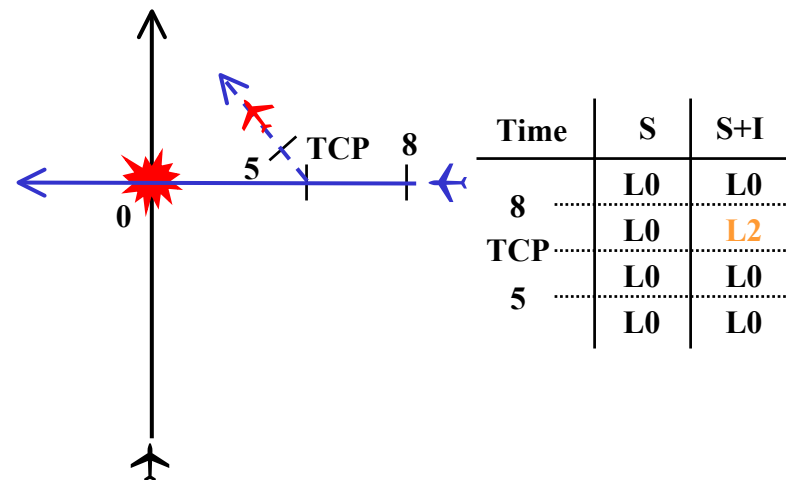
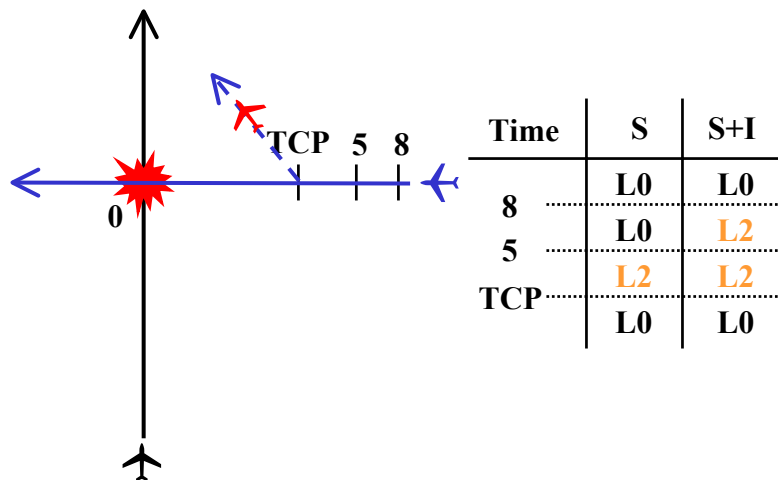


Example: Intent/State Conflict

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Conformance

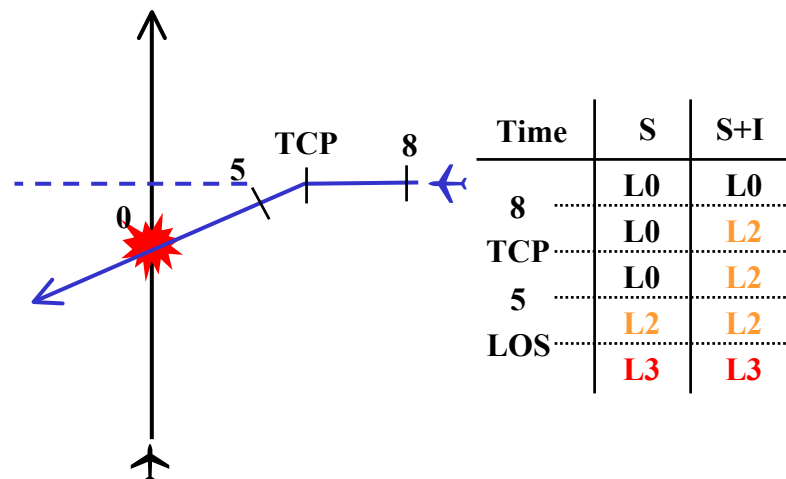
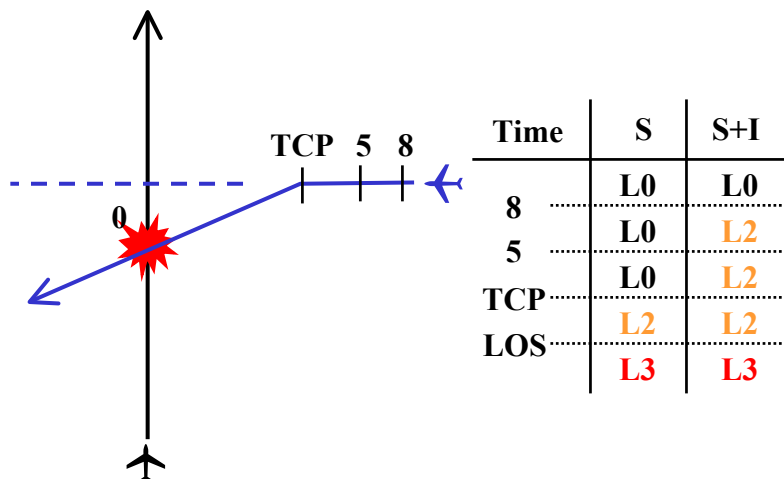


Non-conformance

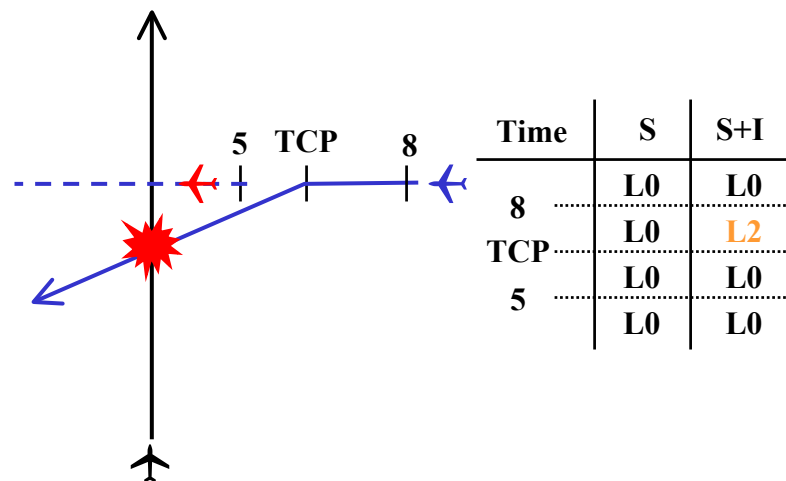
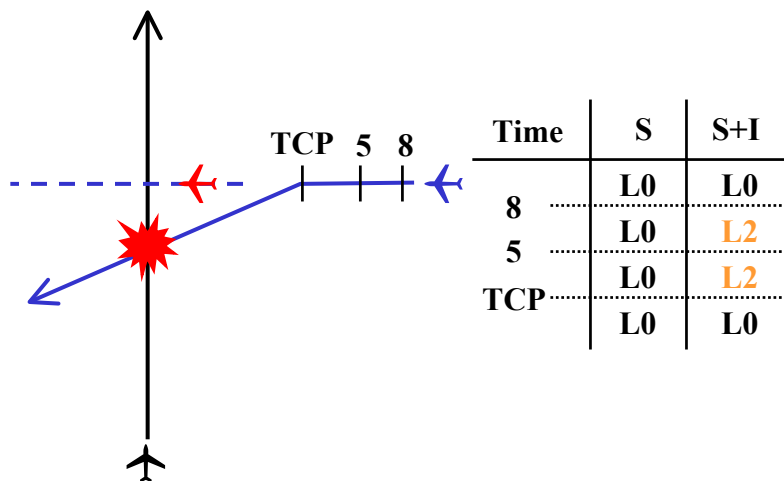


Example: Intent Conflict

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Conformance

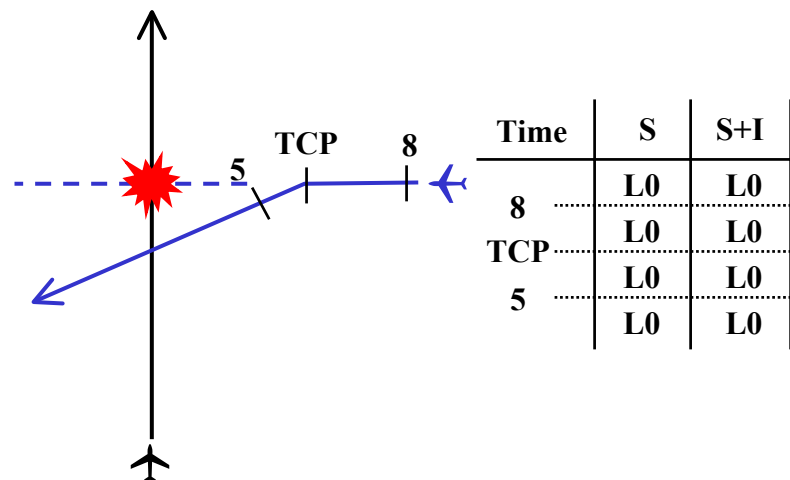
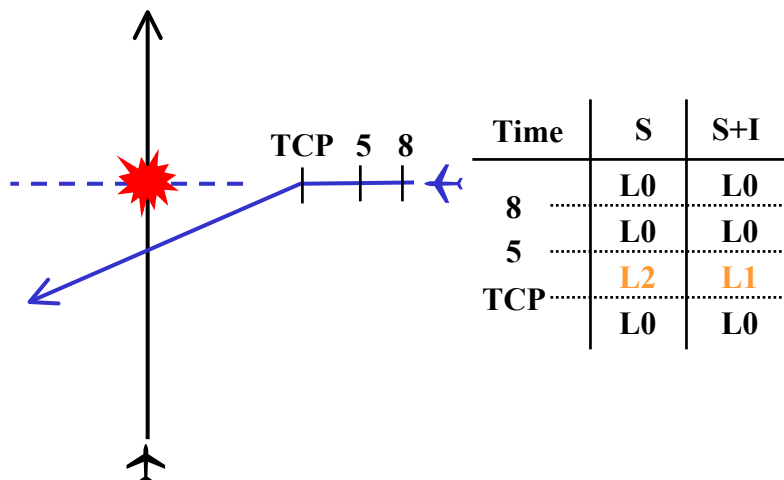


Non-conformance

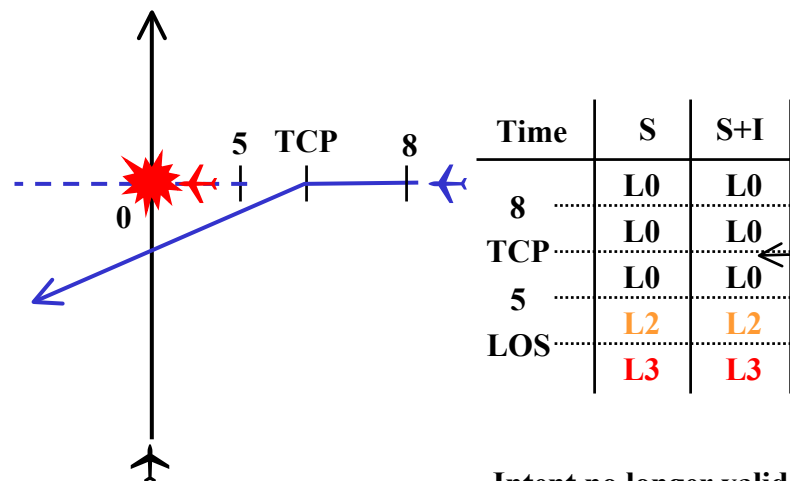
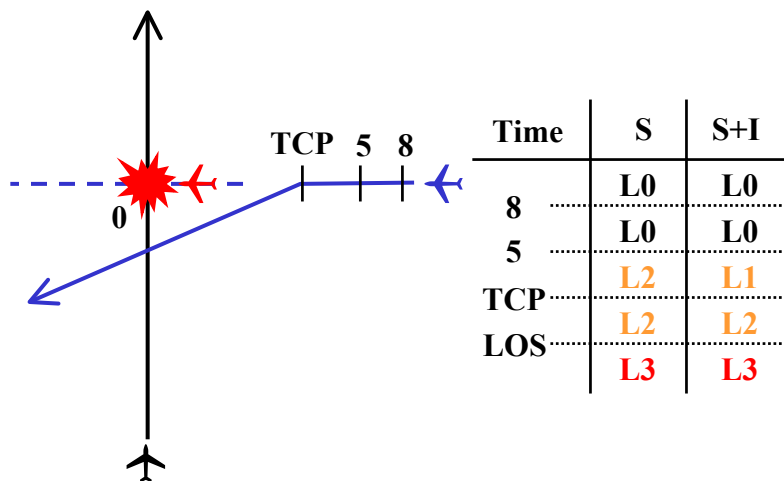


Example: State Conflict

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Conformance



Non-conformance

Intent no longer valid,
so it waits for state horizon